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Scandinavian Herring Periods

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During the 1950 meeting of ICES an account was given of the theories about the tribe of herring responsible for the great Swedish fisheries at Bohuslän. Those fisheries have been supposed to be cyclic with a period of about 110 years.

F.Heincke was the first who intensively examined samples from that herring fishery. He decided the herring were identical with those spawning at the Jutland bank. Later, K.A.Andersson investigated the herring in the Kattegat and in the eastern Skagerak. The only tribe found abundantly in the winter in that area is identical to what Andersson called the "Fladen" herring. Andersson believed the Fladen herring were responsible for the great herring fisheries at Bohuslän. He started his investigations several years after the last Swedish period had ended in 1896. Since then there has been no great herring fishery inside the skerries of Bohuslän.

Hjort and Lea showed that great fluctuations in herring tribes were caused by variations in the strength of year-classes. It is generally accepted that the cyclic nature of the Bohuslän fisheries was caused by fluctuations in the stock of Fladen herring. Other scientists, including Otto Pettersson, believed the Norwegian tribe of herring was responsible for the herring periods at Bohuslän. They noted that the Norwegian spring herring fisheries and the Bohuslän fisheries alternated in productivity. The alternation could be traced far into antiquity. The alternation was noticed by Peder Clausen Friis in the 1950's and by the Norwegian clergyman Ström in 1782.

In 1808 one great Swedish fishing period ended and in 1808 the Norwegian spring herring fisheries started again after a long interruption. The Norwegian fisheries persisted until 1869. Then a great decline in output began and the low period lasted until 1897. That year the herring again appeared in great abundance in the Norwegian spring herring district. The previous year, 1896, had been the end of a Swedish period inside the skerries. Since 1897 the Norwegian west-coast fisheries have yielded great quantities of herring. Concurrently, no great quantities of herring have appeared off the Swedish coast.

The samples from the last Swedish period, 1877-1896, were sparse. Heincke's sample upon which he based his theory was procured from the fishmarket in Kiel. Later he got an additional sample from an undetermined origin. There is no doubt that the samples were from a North Sea tribe. Trybom secured samples during the Swedish fisheries of that era. Those samples show 30% of the herring to have been over 30 cm. in total length. Herring from the Fladen tribe seldom reach a length greater than 30 cm.

During the Swedish fisheries a great herring fishery also grew up on the Norwegian side of the border. Samples were taken from the Norwegian catches. The net-caught herring had a mean size of about 33-34 cm. We know that the mesh-sizes used at that time by the Norwegians were approximately 18 knots in stretched dry net per Norwegian el (62.7 cm.). That means that the fishermen were using nets with meshes so large that to-day they are only used for catching the big Icelandic herring. In 1897 some of the fishermen went to the Norwegian spring herring district after the fisheries near the border stopped in 1896. They began using the same large nets, but the next season they changed to smaller mesh sizes, about 20 knots in stretched dry net per Norwegian el(62.7 cm.). We may assume that the fishermen chose to employ the most efficient mesh in each instance.

The samples taken for biological purposes from the Norwegian side of the border were insufficient to allow one to deduce the origin of the herring supporting the fishery. When the herring were sold the larger fish got a better price. The quality of the herring was then determined by the number of fish in a measure barrel.

Many records of the number of herring contained in a measure barrel are still available for study. The average number rose only slightly during the main season from October to December. Even in December there were less than 500 fish in a barrel of 150 litres. If these fish had been Fladen herring of the size they attain to-day, there would have been more than 1000 fish in such a barrel. The mean size of the herring was about 33-34 cm. The only great tribe of herring of such a size is the Norwegian-Icelandic herring.

During the great Swedish herring fisheries which lasted from 1748 to 1808 a great herring oil industry was developed in Bohuslän. The output of oil was 4-10 %. The best results were obtained at the start of the season and yields diminished as the season progressed. The Fladen herring are an autumn spawning tribe. After spawning in the middle of the North Sea they migrate to the inner Skagerak and Kattegat and pass the winter there. The total fat content of the herring from the later years (A.J.C. Jensen, 1950) was even smaller than the yield taken from the old equipment. Even with modern equipment it is impossible to carry out a profitable oil industry based on the Fladen herring caught in the Kattegat in the winter.

The Norwegian spring herring is also cyclic in appearance. Decades of plenty and decades of scarcity are carefully recorded. The cycle could be explained as the result of fluctuations in the stock. The Norwegian tribe therefore should have been very low from 1870 to 1897. The winter herring fisheries did give an extremely low output, but the fat herring fisheries were the richest on record. The fat herring are simply the young, immature part of the stock. It might be supposed that the fat herring fisheries made such great inroads upon the stock that only a few fish reached maturity. Such an explanation, however, is not convincing. In this century, in addition to the fat herring fisheries, there is also a small herring fishery and a great expansion in the winter herring fisheries. Such intense fishing would be expected to reduce the tribe abruptly, but we can ascertain no diminution in the stock of mature fish caused by fishing.

If we assume that the same tribe supports the great Norwegian and Swedish herring fisheries everything is easy to explain. The alternation of the two fisheries is quite clear. The fat contents of the Norwegian herring taken from October to January provide a reasonable explanation of the high oil output of the old Swedish industry.

If the spawning area were moved from the Norwegian west coast into the inner Skagerak and Kattegat we know that the larvae would be transported eastwards and northwards along the Norwegian coast. The larvae would then have a greater distance to cover before passing the entire Norwegian coast. In this century, when the main spawning area has been the Norwegian west coast, the larvae are still drifted northwards. However, before they have reached the size of fat herring the greater part has already passed the Norwegian coast. That may also be the reason why the larger fat herring have usually only been obtained in the fjords of northernmost Norway in this century. The main body of fat herring has apparently been transported into the Barents Sea.

Heincke's sample from the market in Kiel is not difficult to explain. The Fladen herring are taken together with the Norwegian herring during a Swedish period. Since the Fladen herring are too meagre to be used for reduction or salting they must be used as fresh fish. The samples of Trybom demonstrate clearly that a mixture of tribes was present in the area.

When the great herring fisheries of Sweden are in progress the fish penetrate inside the skerries every year. That may happen for several decades in succession. When the Norwegian spring herring fisheries were good the herring on the Swedish coast did not enter the fjords of Bohuslän, even though K.A.Andersson showed that the tribe is abundant in the Kattegat every winter. One could believe that the herring were driven inside the Bohuslän skerries by special hydrographical conditions. That such conditions occur as long as the period of herring abundance lasts and does not happen between the periods is beyond our present understanding.

If the Norwegian herring were involved, the periodic appearance would be understandable. The herring would then arrive off Sweden to spawn. The bottom conditions fitted for spawning would be found only off the Bohuslän coast. The bottom of the Kattegat is mostly clay, not fitted for herring spawning.

The Fladen herring do not visit the Kattegat for spawning, but to spend the winter, possibly because of the low temperature found there. After spawning in September in the North Sea it might be necessary for the Fladen herring to go through the winter at a low temperature to reduce the metabolism to a point satisfactory for passing the winter. That would be necessary if the food in the North Sea were too scarce to nourish the recovery of the fish after spawning. The Kattegat is very cold in the winter.

The Norwegian winter herring fisheries are carried out on a spring-spawning tribe. The spawning time seems labile. In later years we have been able to follow the movements of the mature part of the tribe with the research ship "G.O.Sars". After spawning off the west coast of Norway the herring go out into the Norwegian Sea. They are found in the border region between the Arctic water coming southwards between Jan Mayen and Iceland and the Atlantic water surrounding that current.

During the feeding period the development of the gonads progresses fairly fast. Late in August fish are found in Heincke's stages IV and V, especially the males. In October the herring leave the relatively warm surface water and dive down in the cold Arctic water. The fish spend at least three months of the year and a part of January in that cold water. In the daytime the fish are located at depths as deep as 400 m. There the temperature is about 0°C. In the evening the schools rise to the surface where the temperature is about 3°C. In the summer the fish are usually found in temperatures between 6 and 8°C. both night and day.

It seems that the development of the gonads slows down when the fish are in cold water. The stage of the gonad development is still about the same when the fish arrive in January off the Norwegian coast. The herring arrive in late December or in January. The spawning starts about a month later whether they have arrived early or late. The herring spawn in 5-7°C. It is therefore likely that the different dates of arrival are a result of the length of time the herring stayed in warm water the preceding summer. If the fish were kept longer than usual in warm water, 6-8° C., the metabolism and the development of the gonads would go further and the fish would arrive to spawn at an earlier date.

There are observations that indicate the herring were living in warmer water in the critical years around 1870, when they last disappeared from the Norwegian spring herring districts. If the same herring was responsible for the great Swedish fisheries which started in 1877, the spawning time must have been about three months earlier. The observations we have of air and sea temperature show no alterations that could be responsible for such a change in the spawning time. However, in 1868 immense schools of herring were discovered off the coast of northern Norway in the autumn. The herring went into the fjords and a fishery was started. The fish disappeared before Christmas, but came back every autumn until 1874. Those herring were examined by G.O.Sars and other scientists. The fish were called "large herring" and the data indicate they were the same tribe of herring as the so-called spring herring. The output of the fishery grew to about 2 million hectolitres in the best season. That is at least of the same order of magnitude as the spring herring fishery of that time.

Off north-western Norway there is no really cold water in the autumn. The 0-isotherm is usually found at a depth of 600-800 m. If the herring remained off the Norwegian coast through the summer in the critical years around 1870, they would find no cold water within reasonable depth and might be forced to live in much higher temperature through the autumn than when they are living in the east Icelandic Arctic Current. The metabolism and the development of the gonads would be faster and the spawning time earlier.

In 1875-76 we do not know where the herring were. In 1877 immense schools arrived in the Bohuslän area. If the herring arrived in the area that is now their home during the feeding period, then it is likely that they would begin their spawning migration earlier than they do now. However, if they approached the western Norwegian coast in October they met coastal water of 10-12°C. The mature part of this tribe has never been found in such warm water. If the fish swam below the surface layer then they could continue farther southwards in the Norwegian channel, in water about 8°C. Observations of great herring schools passing the south and west coasts of Norway in October and November in 1877-96 are numerous (H.L.Buvig,---; O.S.Jensen, ---; S.A.Buck,---;).

Thus the herring would arrive in the Kattegat. In the spring layer between the Baltic water and the bottom water of the Kattegat they would find suitable temperature for spawning.

After spawning early in the winter they would swim for still colder water, found as soon as the thin surface layer cooled down. The Swedish herring fisheries at that time were carried out with land seines which only took the herring in the surface layers. That may be the reason why they got most spent herring in their catches. The cooling of the surface layer happens earliest in the fjords and sounds, later out in the Kattegat. That may be the reason why the herring penetrated the skerries and went into the fjords.

Swedish periods have terminated when the herring arrived later and later in the year. (A.V.Ljungman; A.Boeck). In 1808 and 1896 the close of the cycle followed three successive cold winters. When the herring arrive late at the Swedish coast they are likely to arrive late off the Norwegian coast. If they should arrive at such a late date that the winter cooling of the Norwegian coastal water had reached suitable temperatures the herring would not continue to Sweden. Usually 12 months pass between spawnings, so it is probable that the herring would find suitable temperatures also the next years and therefore use Western Norway grounds as spawning area.

The end of a Norwegian period is also characterized by the arrival of the herring at a later and later date. The explanation of the great quantities of herring off northern Norway in the autumn 1868-74 might be that when the herring left the Norwegian coast at a late date they had to pass the border region between the Norwegian coastal water and the Atlantic water at the time planktonic food is most abundant in the area. The plankton has been shown to be most abundant in April by G.O.Sars, J.T.Ruud, K.F.Wiborg, and others. If this was the case the herring might have stopped where the food were plentiful and moved northwards in the border region, remaining on the eastern side of the Norwegian Sea. If it passed the critical area in March the plankton was scarce and the fish had to move farther westwards against an increasing temperature.

The recent scarcity of herring off north Iceland might be explained similarly. It does not appear that the tribe has dimished. The fishery on the Norwegian coast is based on the same tribe (Fridriksson, 1944). The herring might be leaving the Norwegian coast at a later date than in the years when the herring were numerous north of Iceland. In former years when the fish moved westwards, the east coast of Iceland has been blocked by cold water masses. The herring, therefore, might have continued on the southern side of Iceland and gone northwards in the Denmark Strait, between Iceland and Greenland. In fact, the fishery started on the most westerly corner of north Iceland in the good years. The largest herring of the tribe were caught there. Those herring are the first to spawn and to leave the Norwegian coast after spawning.

The fat content of the large herring caught off NW. Iceland was extremely high for early summer. This indicates that the fish had taken food in water of fairly high temperature.

Later in the summer a warm, northgoing bight is formed off east Iceland and the last herring which left the Norwegian coast might go northwards in that bight and not make the journey south of Iceland. The size of the fish in the samples taken off eastern Iceland was smaller in those years. In the later years when there has been scarcity of herring off north Iceland the samples from east Iceland have also contained the big herring. The herring now leave the Norwegian coast at such a late date that when they arrive east of Iceland the northgoing bight of warm water has already formed. Then the fish do not go around south Iceland and the fisheries off the north coast are poor. The late date of arrival is one suggestion, climatic changes another. Both factors, if the hypothesis is correct, will result in scarcity of herring off north Iceland.
